SECTION C — (3 × 10 = 30 marks)

Answer any THREE questions.

16. At the point in an incompressible fluid having spherical polar coordinates (r, θ, ψ), the velocity components are $\left(2Mr^{-3}\cos\theta, Mr^{-3}\sin\theta, 0\right)$, where M is a constant. Show that the velocity is of the potential kind. Find the velocity potential and the equations of the streamlines.

17. Discuss the case of steady motion under conservative body forces.

18. Discuss about Stokes's stream function.

19. Prove that for an irrotational incompressible two-dimensional flow, the functions $\phi(x, y)$, $\psi(x, y)$ are harmonic functions and the families of curves ϕ=constant and ψ=constant intersect orthogonally.

20. Discuss the relation between Cartesian components of stress.

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NOVEMBER/DECEMBER 2024

DMA42/GMA42 — FLUID DYNAMICS

Time : Three hours Maximum : 75 marks

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SECTION A — (10 × 2 = 20 marks)

Answer ALL questions.

1. Define fluid dynamics.

2. Define a streamline.

3. Define the hydrostatic pressure at any point.

4. Write the most general form of Bernoulli's equation.

5. Define a simple source.

6. Define the vector moment of the doublet.

7. Define the complex velocity potential.

8. State the Milne – Thomson circle theorem.

9. Define the stress matrix.

10. Write the tensor form of the Navier-stokes equation of motion.

SECTION B — (5 × 5 = 25 marks)

Answer ALL the questions.

11. (a) Explain the equation of continuity.

Or

(b) Liquid flows through a pipe whose surface is the surface of revolution of the curve $y=a+\frac{kx^2}{a}$ about the x-axis $(-a\le x\le a)$. If the liquid enters at the end $x=-1$ of the pipe with velocity V, show that the time taken by a liquid particle to traverse the entire length of the pipe from $x=-a$ to $x=+a$ is $\frac{2a}{V(1+k)^2}\left(1|+\frac{2}{3}k+\frac{1}{5}k^2\right)$.

12. (a) Derive the Euler's equation of motion.

Or

(b) Discuss about the pressure at a point in a moving fluid.

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13. (a) Prove that the image of a doublet in an infinite rigid plane is an equal doublet symmetrically disposed with respect to the plane.

Or

(b) Explain the doublet in a uniform stream.

14. (a) Explain the magnus effect.

Or

(b) A two dimensional doublet of strength $\mu\bar{i}$ is at the point $z=ia$ in a stream of velocity $-V\bar{i}$ in a semi-infinite liquid of constant density occupying the half plane $y>0$ and having $y=0$ as a rigid boundary. Show that the complex potential of the motion is $w=VZ+\frac{2\mu Z}{Z^2+a^2}$.

15. (a) Explain the rate of strain quadric and principal stresses.

Or

(b) Discuss the stress analysis in fluid motion.